outer rings, at least one of the raceway surfaces of the inner and outer rings and the rolling surfaces of the rolling elements being provided with a topography comprising recesses which are generally isolated by lands, the method comprising:

forming the recesses by shot peening the at least one of the surfaces,

wherein an average angle α between a wall of each recess on the at least one surface is less than 5 degrees.

5. (Amended) The method according to claim 4, wherein the diameter of each glass bead is about 200 micrometers.

REMARKS

Claims 1-2 and 4-6 are pending. By this Amendment, claims 1 and 5 are amended, claim 3 is canceled, and the specification has been amended. Claim 5 is not intended to narrow the scope of the claimed subject matter. No new matter has been added. Reconsideration in view of the above amendments and following remarks is respectfully requested. The attached Appendix includes a marked-up copy of each rewritten claim (37 C.F.R. §1.121(c)(1)(ii)).

Please replace the specification with the substitute specification attached hereto. The substitute specification includes no new matter. The specification has been amended to make minor typographical revisions. Specifically, the "SUMMARY OF THE INVENTION" heading was originally misplaced in this application. This application is based on parent Application No. 09/486,210 which was originally filed without section headings. The substitute specification appropriately places the "SUMMARY OF THE INVENTION" label at its correct location in the substitute specification. Support for this amendment to the specification is evidenced by the placement of the support for the recited claims in this application. For example, support for the subject matter recited in original claim 3 is provided in the specification at original paragraph [0003], now paragraph [0004]. Thus, the

"SUMMARY OF THE INVENTION" heading should be placed before this supporting language. Applicants include a marked-up copy of the specification in accordance with 37 C.F.R. 1.125(b)(2).

The Office Action rejects claims 1-6 under 35 U.S.C. §103(a) over JP 04321816 to Toru in view of U.S. Patent 5,592,840 to Miyasaka. This rejection is respectfully traversed.

Neither Toru nor Miyasaka teach, suggest, or render obvious all of the features recited in claim 1. In particular, none of the applied references teach or suggest a method of forming the recesses by shot peening at least one of its surfaces, wherein an average angle α between a wall of each recess on the at least one surface is less than 5 degrees.

Toru discloses a cylindrical roller bearing 11 having "a number of independent tiny recesses of concave shape" arranged. See, e.g., the Abstract. The Office Action correctly acknowledges that Toru fails to teach or suggest forming of the recesses by shot-peening. Furthermore, Toru is absolutely silent about any of the recesses having an angle, let alone at least one surface less than 5 degrees, as recited in claim 1.

Miyasaka fails to cure the deficiencies of Toru discussed above with respect to claim 1. Miyasaka discloses shot-peening a surface of a portion of a metal-product. However, Miyasaka is absolutely silent about a method of providing recesses by shot-peening such that the recesses have an angle less that 5 degrees. In fact, the surface of the portion of the metal-product may be exposed to a sliding action. See, e.g., the Abstract.

Therefore, none of the applied references teach or suggest forming the recesses by shot peening at least one of its surfaces, wherein an average angle α between a wall of each recess on the at least one surface is less than 5 degrees, as recited in claim 1.

Accordingly, the Office Action has not established a prima facie case of obviousness, as the applied references fail to teach or suggest all of the subject matter of independent claim 1. Accordingly, the applied references also fail to render obvious the subject matter of claims

2-6, which depend from claim 1. Withdrawal of the rejection under 35 U.S.C. §103(a) is therefore respectfully solicited.

In view of the foregoing, Applicants respectfully submit that this application is in condition for allowance. Favorable consideration and prompt allowance are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicant's undersigned representative at the telephone number listed below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Robert Z. Evora
Registration No. 47,356

JAO:RZE

Attachment:
- Appendix
- Substitute Specification
- Marked-up Copy of the Specification
- Petition for Extension of Time

Date: November 27, 2002

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461

APPENDIX

Changes to Specification:

A Substitute Specification, and a marked up version thereof showing all changes to the specification of record, are attached in accordance with 37 C.F.R. 1.125(b)(2).

Changes to Claims:

Claim 3 is canceled.

The following is a marked-up version of the amended claim:

1. (Twice Amended) A method of manufacturing a roller element bearing comprising an inner ring, an outer ring, and a series of rolling elements, a rolling surface of each rolling element in contact with a raceway surface formed in each of the inner and the outer rings, at least one of the raceway surfaces of the inner and outer rings and the rolling surfaces of the rolling elements being provided with a topography comprising recesses which are generally isolated by lands, the method comprising:

forming the recesses by shot peening the at least one of the surfaces,

wherein an average angle α between a wall of each recess on the at least one surface is less than 5 degrees.

5. (Amended) The method according to claim 4, wherein the diameter of each glass beads is about 200 micrometers.

MARKED-UP COPY OF SPECIFICATION

METHOD OF MANUFACTURING A ROLLING ELEMENT BEARING WITH IMPROVED ROLLING CONTACT SURFACES

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention is related to a rolling elements, the rolling surface of which is in contact with a raceway of both rings, at least one of the surfaces of the rings and the rolling elements being provided with a topography comprising recesses which are generally isolated from each other by lands and which may contain a lubricant, said recesses having a maximum diameter of 100 micrometer in a direction parallel to the surface in question.

SUMMARY OF THE INVENTION

2. Description of Related Art

[0002] Such rolling element bearing is disclosed in WO-A-9719279. The object of [the] this invention is to provide a rolling element bearing wherein a good compromise is achieved between a sufficient lubrication capacity on the one hand, and only a small disturbance of the running properties on the other hand.

[0003]

[0003] Said object is achieved in that the recesses have a minimum diameter of 14 micrometer, and in that, in a cross section, the average angle α defined by the intersection of the wall of a recess and the adjacent surface is less than 5 degrees.

[0004] The recesses with such size appear to behave as pockets which are flattened during overrolling, resulting in an extra amount of lubricant being expelled and fed into the contact as an EHL (elasto-hydrodynamic lubrication) lubricant film. Thereby, the rolling surfaces will be separated already at a lower speed.

[0005] Preferably, the average size of the recesses in a direction parallel to the surface is 50 micrometer. Further, the recesses may have a maximum depth of 4 micrometer; preferably, the recesses have an average depth of less than 0.5 micrometer. The depth preferred is about 0.2 μm.

[0006] It appears that the geometry of the recesses is of importance for obtaining a good lubricant film at low speeds. In particular, it appears to be advantageous in case, in a cross section, the average angle defined by the intersection of the wall of a recess and the adjacent surface is less than 2 degrees.

[0007] Thereby, an improved lubrication may be obtained in combination with improved fatigue life properties. The average surface area may be more than 150 μm.

[0008] In this respect, it is preferred that the recesses are spherically shaped. A spherical geometry provides a well defined recess, having the required lubricant holding capacity and providing the possibility to locate the recesses close to each other in a non-overlapping way, thus maintaining lands which isolate the recesses from each other. Such recesses may be obtained by a peening operation.

~~SUMMARY OF THE INVENTION~~

[0009] According to a first possibility, the topography comprising recesses may be applied to at least one of the rolling surfaces of the rolling elements, and/or at least one of the raceways of the rings.

[0010] The topography in a direction transverse with respect to the direction of rolling may be varying. For instance, the depth and/or the density of the recesses (number of recesses per unity of surface area) may be varying. This embodiment of the rolling bearing according to the invention is in particular useful in the case of varying lubrication requirements.

[0011] According to a second possibility, the topography comprising recesses may be applied in a roller bearing wherein at least glass beads are used in the shot peening operation.

[0012] The invention is furthermore related to a method for manufacturing a rolling element or a ring for a bearing as described before, wherein at least one of the rolling surfaces and the raceways is provided with a topography comprising recesses which are generally isolated from each other by lands and which may contain a lubricant, which topography in a direction transverse with respect to the direction of rolling is varying. Preferably, glass beads are used in the shot peening operation. The diameter of the glass beads should be about 200 micrometer.

[0013] The invention will now be described further with reference to the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1 shows a cross-section through a single row cylindrical roller bearing.

Figure 2 shows a detail of a surface of the bearing according to figure 1.

Figure 3 shows a cross-section through said surface.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The cylindrical roller bearing according to figure 1 comprises an outer ring 1, an inner ring 2 consisting of two halves 3, 4, as well as a series of cylindrical rollers 5

[0016] Both the outer ring 1 and the inner ring 2 have two integral flanges 6 respectively 7. Between these flanges, raceways 8 respectively 9 have been defined.

[0017] The cylindrical rollers have flat end faces 10, which can slidably contact the facing surfaces 11 respectively 12 of the integral flanges 6 respectively 7.

[0018] According to the invention, at least one of the surfaces of the rolling elements 5 and/or the rings 1, 2 may be provided with a surface topography as shown in figure 2. The surface in question may be the rolling surface of the cylindrical rollers 5, their end faces 10, or the raceways 8, 9 and/or the facing surfaces 11, 12 of integral flanges 6,7.

[0019] As shown in figure 2 said topography of e.g. raceway 8 comprises a number of spherically shaped recesses 13, which may have varying dimensions. These spherically recesses 13 are e.g. obtained by means of shot blasting glass beads. The recesses 13 are generally isolated from each other by means of lands 14 which are part of the raceway 8 in question. The recesses 13 constitute small pockets in which oil may be trapped. When a rolling element overrolls with the recesses 13, they are compressed somewhat, whereby the oil is expelled and a better lubrication is obtained.

[0020] Figure 3 shows a cross-section of recess 13. According to the invention, their maximum size a in a direction parallel to the raceway 8 is 100 μm. Furthermore, their maximum depth is 4 μm. The average depth of the recesses is preferably 0.2 μm.

[0021] In order to guarantee a smooth overrolling of the recesses 13 by the rolling elements, the average angle α defined by the intersection of the wall of the recess 13 and the adjacent land 14 is 2°.